$2.00

Simpson

INSTRUMENTS THAT STAY ACCURATE

OPERATOR'S MANUAL

SIMPSON 470

DIGITAL MULTIMETER

WARNING

For safe usage, it is essential that the operator read this manually carefully before using the instrument for any measurement.

SIMPSON ELECTRIC COMPANY
A Katy Industries Subsidiary
853 Dundee Avenue, Elgin, Illinois 60120
(312) 697-2260 • Telex 72-2416 • Cable SIMELCO
IN CANADA: Bach-Simpson, Ltd., London, Ontario
IN ENGLAND: Bach-Simpson (U.K.) Ltd., Wadebridge, Cornwall

DIGITAL INSTRUMENT
Warranty

SIMPSON ELECTRIC COMPANY warrants each digital instrument manufactured by it to be free from defects in material and workmanship under normal use and service, its obligation under this warranty being limited to making good at its factory any digital instrument which shall within one (1) year after delivery of such instrument or other article of equipment to the original purchaser be returned intact to it, or to one of its authorized service stations, with transportation charges prepaid, and which its examination shall disclose to its satisfaction to have been thus defective; this warranty being expressly in lieu of all other warranties expressed or implied and of all other obligations or liabilities on its part, and SIMPSON ELECTRIC COMPANY neither assumes nor authorizes any other persons to assume for it any other liability in connection with the sale of its products.

This warranty shall not apply to any digital instrument which shall have been repaired or altered outside the SIMPSON ELECTRIC COMPANY factory or authorized service stations, nor which has been subject to misuse, negligence or accident, incorrect wiring by others, or installation or use not in accord with instructions furnished by the manufacturer.

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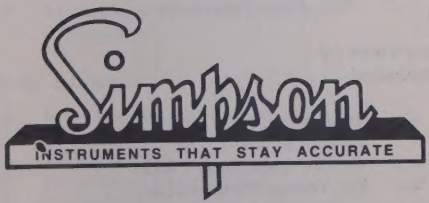

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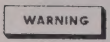
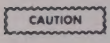
NOTE: This Operator's Manual contains information essential to the operation of this Instrument. Therefore, it should be kept in a convenient place and used for reference as required.

SAFETY SYMBOLS

This marking adjacent to another marking or a terminal or Operating device indicates that the Operator must refer to an explanation in the Operating Instructions to avoid damage to the equipment and/or to avoid personal injury.



This WARNING sign denotes a hazard. It calls attention to a procedure, practice or the like, which if not correctly performed or adhered to, could result in personal injury.



This CAUTION sign denotes a hazard. It calls attention to a procedure, practice or the like, which if not correctly adhered to could result in damage to or destruction of part or all of the Instrument.

HIGH VOLTAGE TERMINAL: A terminal at which a voltage, with respect to another terminal or part exists or may be adjusted to 1000 volts or more. The symbol is an additional warning that a very dangerous voltage may exist at the terminal, and its connecting leads must not be handled while energized.

GROUNDED TERMINAL (PROTECTIVE): A terminal which must be connected to earth ground by the Operator or Installer prior to making any other connections to the equipment for personal protection from electrical shock.

SAFETY SYMBOLS

GROUNDED TERMINAL: A terminal which is connected to earth ground by means of an earth grounding system and which is intended to be connected to other circuits or equipment by the Operator or Installer for purposes other than protection from electrical shock.

WARNING

This instrument is designed to prevent accidental shock to the operator when properly used. However, no engineering design can render safe an instrument which is used carelessly. Therefore, this manual must be read carefully and completely before making any measurements. Failure to follow directions can result in a serious or fatal accident.

SHOCK HAZARD: As defined in American National Standard, C39.5, Safety Requirements for Electrical & Electronic Measuring & Controlling Instrumentation, a shock hazard shall be considered to exist at any part involving a potential in excess of 30 volts rms (sine wave) or 42.4 volts DC or peak and where a leakage current from that part to ground exceeds 0.5 milliampere, when measured with an appropriate measuring instrument defined in Section 11.6.1 of ANSI C39.5.

NOTE: The proper measuring instrument for the measurement of leakage current consists essentially of a network of a 1500 ohms non-inductive resistor shunted by a 0.15 microfarad capacitor connected between the terminals of the measuring instrument. The leakage current is that portion of the current that flows through the resistor. The Simpson Model 229-Series 2 AC Leakage Current Tester meets the ANSI C39.5 requirements for the measurement of AC leakage current and can be used for this purpose. To measure DC leakage current, connect a 1500 ohm non-inductive resistor in series with a Simpson 0-500 DC microammeter and use this as the measuring instrument.

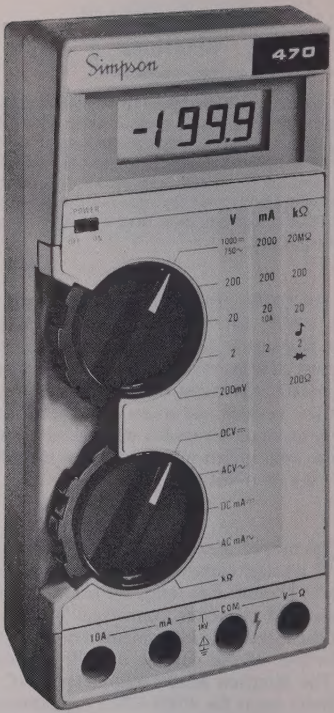


Figure 1-1. Digital Multimeter, 470.

SECTION I
INTRODUCTION

1.1 GENERAL

1.1.1 The Simpson 470 Digital Multimeter (hereafter referred to as the 470 or simply the Instrument), is a hand-held 3½ digit, compact instrument suitable for use in general electronic maintenance, production, and laboratory. This multimeter is designed for the service person who values true portability, reliability, simplicity, and the ruggedness of a precision instrument. It features, 0.15% DC voltage accuracy, single 9V battery operation, large LCD display, transient suppression capability and rotary switch selection for ranges and functions. Additional features are automatic polarity, automatic zeroing, high input impedance for voltage measurements, excellent overload protection characteristics and continuity detection with audible indication. This Instrument is available in Brown, Catalog No. 12554, and Gray, Catalog No. 12558 (470G).

1.1.2 The 470 measures DC and AC voltage, DC and AC current and resistance as specified in Table 1-2. The Analog-To-Digital (A/D) conversion circuitry is contained in one Large-Scale Integration (LSI) module which provides high reliability and compact design.

1.1.3 The 470 is designed to operate continuously for 200 hours using a single 9V alkaline "transistor" battery (NEDA 1604A). However, a carbon-zinc type battery (NEDA 1604) may be substituted. (Operation will be reduced to 100-150 hours.) "Lo Bat" on the display is used to indicate low battery voltage and signify a battery life of 20 hours remaining.

1.1.4 The numerical display is a 3½ digit, 7-segment liquid crystal display (LCD). The high contrast numerals

are 0.5 inches high and are in a single plane for distant and wide angle viewing.

1.2 SUPPLIES AND ACCESSORIES

1.2.1 All supplies and accessories required for the operation of the 470 are furnished with the Instrument, and listed in the accompanying Table 1-1. Available replacement parts are listed in Table 7-2.

Table 1-1. Items and Accessories Furnished With This Instrument

Quantity	Description	Part No.
1	Operator's Manual	6-112834
1	Battery, 9 V Alkaline (NEDA 1604A)	5-114907*
1	Test Lead Set: One black and one red insulated lead having probe tips with provisions for screw-on alligator clips.	00043
1	Alligator Clip Accessory Kit	10-864240

*Batteries are standard items replaceable through local retail stores.

1.3 SAFETY CONSIDERATIONS

1.3.1 This Operator's Manual contains cautions and warnings alerting the user to hazardous operating and service conditions. This information is flagged by CAUTION or WARNING headings throughout this publication, where applicable, and are defined at the front of the manual under SAFETY SYMBOLS. To ensure the safety of operating and servicing personnel and to retain the operating conditions of the Instrument, these instructions must be adhered to.

1.4 TECHNICAL DATA

1.4.1 Table 1-2 lists the technical specifications for the 470 Digital Multimeter.

Table 1-2. Technical Data

The following electrical specifications are valid for an operating temperature of +18 °C to +28 °C at relative humidity up to 90 percent unless otherwise noted.

1. DC Voltage:

Ranges:	200 mV, 2 V, 20 V, 200 V, 1000 V
Accuracy:	±(0.15% of input + 1 count)
Input Resistance:	10 MΩ, All Ranges
Overload Protected To:	±1000 V (DC + peak AC), All Ranges
Sensitivity:	100 μV on 200 mV range
Full Range Step Response (to rated accuracy):	1 second
Normal Mode Rejection:	50 dB minimum at 60 Hz
Common Mode Rejection:	105 dB minimum at 60 Hz

2. AC Voltage

(Average-Sensing, rms Calibrated Sine Wave)

Accuracy:

Range	Accuracy*	
	45 Hz to 500 Hz	500 Hz to 1 kHz
200 mV	±(1.0% +5)	±(3% +5)
2 V		
20 V		
200 V		
750 V		

**% of input + number of counts*

Input Impedance:	10 MΩ and 100 pF All Ranges
Overload Protected To:	All ranges ±1000 V (DC + Peak AC) except 200 mV which is ± 300 V (DC + peak AC)
Full Range Step Response (to rated accuracy):	3 seconds

3. RESISTANCE:

Ranges:	200 Ω, 2 kΩ 20 kΩ, 200 kΩ, 20 MΩ
Accuracy:	±(0.5% of input + 2 counts) except on the 20 MΩ range which is ±(2% of input + 2 counts)
Open Circuit Voltage:	<3.5 V, All Ranges
Overload Protected To:	250 V RMS, All Ranges
Full Range Step Response (to rated accuracy):	1 second except on 20 MΩ range which is 7 seconds.
Diode Test:	Diode symbol indicated on 2 kΩ range switch position. Measures forward resistance of a semiconductor junction, at approx. 1.0 mA test current.
Continuity: (On 2 kΩ Range)	1 kΩ or less activates audible tone. Overrange de-activates audible tones.

4. DC CURRENT:

Ranges:	2 mA, 20 mA, 200 mA, 2000 mA, 10 A
Accuracy:	±(1% of input + 1 count) except on 2000 mA and 10 A ranges which are ±(2% of input + 1 count)
Burden Voltage:	0.25 V max. except 1.0 V max. on 2000 mA range, 0.3 V max. on 10 A range
Overload Protected To:	±2 A Double Fuse Protected All Ranges except 10 Amp range. 2 A/250 V fuse and 3 A/600 V fuse in series.
Full Range Step Response (to rated accuracy):	1 second

5. AC CURRENT:
(45 Hz to 1 kHz)

Ranges:	2 mA, 20 mA, 200 mA, 2000 mA, 10 A
Accuracy:	±(2% of input + 5 counts) except on 2000 mA and 10 A ranges which are ±(3% of input + 5 counts)
Burden Voltage:	Same as DC (see above)
Overload Protected To:	2 A Double Fuse Protected, All Ranges except 10 Amp range, 2 A/250 V fuse and 3 A/600 V fuse in series.
Full Range Step Response (to rated accuracy):	3 seconds

6. RATED CIRCUIT-TO-GROUND VOLTAGE

(max. common mode voltage): 1000 volts (DC plus peak AC) from any measuring terminal to power line (earth) ground terminal.

7. TRANSIENT PROTECTION: Protected against transients on all voltage and resistance ranges: 6 kV for 100 μS max.

8. DISPLAY

Numerical Display:	3½ digit, 7-segment liquid crystal display (LCD) type, with "low battery" indication
Conversion Rate:	3 readings per second, nominal
DC Polarity Selection:	Automatic "−" indication, "+" sign implied.

9. POWER REQUIREMENT:

Battery Type:	(1) 9-volt "transistor" battery alkaline (NEDA 1604A) or carbon-zinc (NEDA 1604)
Battery Life:	200 hours nominal with alkaline battery

10. TEMPERATURE RANGE:

Operating:	0 °C to +55 °C
Storage:	−40 °C to +70 °C

11. TEMPERATURE COEFFICIENT: (0 °C to 18 °C and 28 °C to 55 °C) Less than 0.1 times the applicable accuracy specification per °C.

12. HUMIDITY RANGE: 90% max., up to +35 °C; 70% max., up to 55 °C (non-condensing).

13. DIMENSIONS:

Height:	1.8″ (4.57 cm)
Width:	3.4″ (8.64 cm)
Depth:	7.1″ (18.03 cm)

14. WEIGHT: 1.0 lb. (.453 kg)

SECTION II
INSTALLATION

2.1 GENERAL

2.1.1 This section contains information and instructions for the installation and shipping of the 470. Included are unpacking inspection procedures, warranty, shipping, power source requirements, installation and care.

2.2 UNPACKING AND INSPECTION

2.2.1 Examine the shipping carton for obvious signs of damage. Inspect the Instrument for possible damage incurred during shipment. If damage is noted, notify the carrier and supplier and do not attempt further use of the Instrument. If the Instrument appears to be in good condition, read the Operator's Manual in its entirety. Become familiar with the Instrument as instructed in the manual, then proceed to check the electrical performance as soon as possible. Also, check that all items are included with the Instrument (Table 1-1).

2.3 WARRANTY

2.3.1 The Simpson Electric Company warranty policy is printed on the inside front cover of this manual. Read it carefully prior to requesting a warranty repair.

NOTE: For assistance of any kind, including help with the Instrument under warranty, contact the nearest Authorized Service Center for instructions (listed on the last pages of this manual.) If it's necessary to contact the factory directly, give full details of any difficulty and include the Instrument model number, serial number (at the back of the Instrument) and date of purchase. Service data or shipping instructions will be mailed promptly. If an estimate of charges for non-warranty or other service work is required, a charge estimate will be quoted. This charge will not be exceeded without prior approval.

2.4 SHIPPING

2.4.1 Pack the Instrument carefully and ship prepaid to the proper destination. Insure the Instrument.

2.5 POWER SOURCE REQUIREMENTS

2.5.1 The 470 is a battery operated instrument. A 9 V "transistor" battery is supplied with the Instrument. (See item 9, Table 1-2 for battery type and paragraph 6.3 for installation.)

2.6 INSTALLATION

2.6.1 As well as being hand held operated, the Instrument may also be operated while set on its rubber feet on its back, at an inclined angle with the bail extended, or at a hanging position with bail repositioned.

SECTION III
CONTROLS, CONNECTORS AND INDICATORS

3.1 GENERAL

3.1.1 All operating controls, connectors and indicators are described in Table 3-1. Become familiar with each item prior to operating the Instrument for the first time.

3.2 FRONT PANEL DESCRIPTION

3.2.1 Table 3-1 lists all front panel controls, connectors and indicators (Figure 3-1 for identification).

Table 3-1. Front Panel Description

1. POWER SWITCH: ON OFF	Slide switch used to apply or turn off power to the Instrument
2. FUNCTION SWITCH:	Connect the input to the appropriate measuring circuits as follows: DCV ⎓ = DC Voltage ACV ∿ = AC Voltage DC mA ⎓ = DC Milliamps AC mA ∿ = AC Milliamps kΩ = Resistance
3. RANGE SWITCH:	Selects the appropriate circuits required to obtain full range measurements as follows:
Voltage:	200 mV, 2 V, 20 V, 200 V, 1000 VDC/750 VAC
Current:	2 mA, 20 mA, 200 mA, 2000 mA, 10 A
Resistance:	200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 20 MΩ

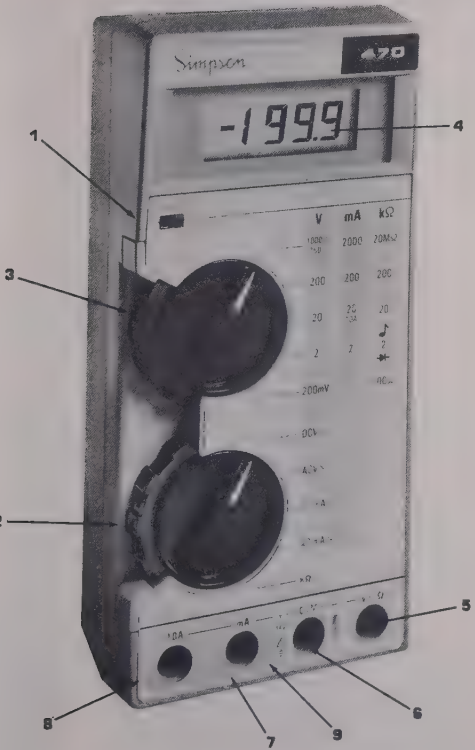


Figure 3-1. Front Panel Description.

4. NUMERICAL DISPLAY: The digital display is a single LCD which includes a "−" polarity sign, ("+" sign is implied), a "1" digit, three 7-segment 0 to 9 digits and a decimal point, to indicate the polarity and the value of the signal being measured. The decimal point is properly positioned by the selection of the range switch. Overrange (or out of range) conditions are indicated by a blank display, except for the most significant "1" digit.

Low battery condition is indicated by "LO BAT" located on the upper left-hand corner of the display. The first appearance of "LO BAT" signifies a remaining battery life of approximately 20 hours.

5. V-Ω JACK: This jack is used to connect, via the red test lead, the "high" or "+" side of the circuit being measured to all voltage and resistance measuring circuits through the range and function switches.

6. COM JACK: This jack is used to connect, via the black test lead, the "low" or "−" side of the circuit being measured to the internal circuit COMMON and is isolated from the AC power line ground. Do not float this terminal more than 1000 (DC plus AC peak) volts away from earth ground.

7. mA JACK: This jack is used to connect, via the red test lead, the "high" or "+" side of the circuit being measured to the current measuring circuits through the range and function switches up to 2000 mA.

8. 10 A JACK: This jack serves the same purpose as mA JACK, but for higher current measurement up to 10 A.

9. Refer to Table 1-2, item 6.

SECTION IV
OPERATING INSTRUCTIONS

4.1 GENERAL

Voltages encountered within the capabilities of this Instrument are dangerous and can be fatal. Read and follow fully the instructions provided in this Operator's Manual and adhere to the following:

4.1.1 Turn off circuit power before connecting and disconnecting test leads.

4.1.2 Do not float the input terminals more than 1000 volts (DC + peak AC) from earth ground.

4.1.3 Do not use this Instrument for making measurements in high voltage and high power circuits unless qualified to do so.

4.1.4 Do not exceed the following input limits:

Function	Maximum Input
AC/DC Volts	±1000 V (DC + peak AC)
	±300 V (DC + peak AC) on 200 mV AC range
AC/DC mA	2 A (Fuse Protected)
OHMS	250 V rms

Failure to stay below these limits can lead to personal injury and/or damage to the Instrument.

4.1.5 For maximum safety, do not touch test leads, circuit or Instrument while power is applied to the circuit being measured.

4.2 BATTERY POWER

4.2.1 Type And Life

4.2.2 The 470 is designed to operate on a single 9 V "transistor" battery (NEDA 1604A for alkaline; NEDA

1604 for carbon-zinc). An alkaline 9 V battery is supplied with the Instrument. Up to 200 hours of continuous operation can be achieved using an alkaline battery; up to 150 hours using a carbon-zinc battery.

4.2.3 Low Battery Indicator

4.2.4 The 470 will automatically detect and display "LO BAT" (upper left-hand corner of display) when the battery voltage is below 7.0 volts approximately. The first appearance of the arrow signifies a remaining battery life of approximately 20 hours.

4.3 GENERAL FUNCTIONAL CHECK:

Note: Prior to operation of the Instrument, review and perform (where applicable) the following notes and checks. These steps can be used also as a general functional check.

a. Connect the black test lead to the COM jack and the red test lead to the V-Ω jack. Short the test leads together.

b. Set the function switch to kΩ and the range switch to 2.

c. Separate the test leads. The numerical display will blank in the out-of-range condition.

d. Short the test leads together. The display reading will return to .000 ± 2 counts.

e. If difficulty is encountered in the above steps, see Section 7, Table 7-1.

4.4 DC VOLTAGE MEASUREMENTS:

a. Review the Safety Precautions in paragraph 4.1

b. Connect the red test lead to the V-Ω jack and the black lead to the COM jack.

c. Set the function switch to DCV ⎓.

d. Set the range switch to the appropriate range. If the voltage being measured is unknown, begin with the 1000 volt DC range.

e. Turn off the power to the device or circuit under test and discharge all capacitors.

CAUTION

Do not attempt to measure voltages on the 1000 VDC range which might be greater than 1000 volts DC.

f. Connect test leads to the circuit being measured.

g. Apply power to the circuit being measured. The Instrument will automatically indicate the correct polarity "–" to indicate negative and no sign to imply positive polarity. The value of the voltage being measured will be indicated on the numerical display.

h. Remove all power from the circuit being measured and discharge all capacitors prior to disconnecting test leads.

4.5 AC VOLTAGE MEASUREMENTS:

a. Review the Safety Precautions in Paragraph 4.1

b. Connect the red test lead to the V-Ω jack and the black lead to the COM jack.

c. Set the function switch to ACV∿.

d. Set the range switch to the appropriate range. If the voltage being measured is unknown, begin with the 750 VAC range.

CAUTION

Do not attempt to measure voltages on the 750 VAC range which might be greater than 750 volts.

e. Remove all power from the circuit being measured and discharge all capacitors.

f. Connect test leads to the circuit being measured.

g. Apply power to the circuit being measured. The value of the voltage being measured will be indicated on the numerical display.

h. Remove all power from the circuit being measured and discharge all capacitors prior to disconnecting test leads.

4.6 RESISTANCE MEASUREMENTS:

a. Review the Safety Precautions in Paragraph 4.1.

b. Connect the red test lead to the V-Ω jack and the black lead to the COM jack.

c. Set the function switch to kΩ.

d. Set the range switch to the appropriate range.

e. If the resistance being measured is connected into a circuit, be certain that all power is removed from the circuit and all capacitors are discharged. Check for current paths other than through the resistance being measured. These paths can result in a measured value which is lower than the actual value of the resistance being measured.

f. Connect the test leads to the resistance being measured. Be careful not to contact adjacent points, even if insulated, particularly when making high resistance measurements. Some insulators can have relatively low insulation resistance, which can sufficiently shunt the resistance being measured to result in a measured value lower than the actual value.

g. Allow time for the display to stabilize. This procedure is especially important when measuring a high value resistance shunted by a large value of capacitance.

h. Disconnect test leads.

4.6.2 DIODE TEST:

a. Set the function switch to "kΩ" function.

b. Set the range switch to "2" range.

c. To measure the forward resistance of a semiconductor junction, connect the cathode of the diode to the COM terminal and anode to the V-Ω terminal. For Silicon diodes, the Instrument should display .550 or higher. For germanium diodes, the Instrument should display .450 or lower.

d. To measure the reverse resistance of a semiconductor junction, the Instrument should display "overrange."

4.6.3 CONTINUITY TEST:

a. Set the function switch to kΩ and the range switch to "2."

b. Connect the red lead and the black lead to the V-Ω and COM jacks respectively.

c. No audible tone should be generated with open test leads.

d. An audible tone should be generated with shorted test leads or connected to a 1 kΩ or less resistor.

4.7 DC CURRENT MEASUREMENTS:

a. Review the Safety Precautions in Paragraph 4.1.

b. Set the function switch to DCmA⎓

c. Select the appropriate current range switch. If the current being measured is unknown, begin with the 10 A range.

d. REMOVE ALL POWER TO THE CIRCUIT BEING MEASURED AND DISCHARGE ALL CAPACITORS.

e. Connect the red test lead to the 10 A jack* and the black test lead to the COM jack.

f. Open the circuit in which the current is to be measured and securely connect the test leads in series.

WARNING

Ensure that a current range is never connected across a voltage source and that the circuit into which the 470 is connected (in series) does not have a voltage, with respect to ground, exceeding the rated circuit-to-ground voltage of the 470 (refer to Table 1-2, item 6).

g. Apply power to the circuit being measured.

h. The value of current being measured is indicated on the numerical display.

**mA jack for measuring any current less than 2000 mA.*

i. REMOVE ALL POWER FROM THE CIRCUIT BEING MEASURED AND DISCHARGE ALL CAPACITORS.

j. Disconnect the test leads and reconnect the circuit which was originally opened.

4.8 AC CURRENT MEASUREMENTS:

a. Review the Safety Precautions in Paragraph 4.1

b. Set the function switch to AC mA~.

c. Select the appropriate current range switch. If the current being measured is unknown, begin with the 10 A range.

d. REMOVE ALL POWER FROM THE CIRCUIT BEING MEASURED AND DISCHARGE ALL CAPACITORS.

e. Open the circuit in which the current is to be measured and securely connect the test leads in series.

WARNING

Ensure that a current range is never connected across a voltage source and that the circuit into which the 470 is connected (in series) does not have a voltage, with respect to ground, exceeding the rated circuit-to-ground voltage of the 470 (refer to Table 1-2, item 6.)

f. Connect the red test lead to the 10 A jack* and the black test lead to the COM jack.

g. Apply power to the circuit being measured.

h. The value of the current being measured is indicated on the numerical display.

i. REMOVE ALL POWER FROM THE CIRCUIT BEING MEASURED AND DISCHARGE ALL CAPACITORS.

j. Disconnect the test leads and reconnect the circuit which was originally opened.

**mA jack for measuring any currrent less than 2000 mA.*

SECTION V
THEORY OF OPERATION

5.1 OVERALL SYSTEM

5.1.1 The basic system block diagram for the 47⁰ is shown in Figure 5-1.

5.1.2 Signal Conditioning Section: The parameter being measured is connected to the input terminals. The corresponding Signal Conditioning circuits convert this parameter into a proportional DC voltage. The conversion is accomplished by the Attenuator, Current Shunts, Resistance Converter, AC-to-DC Converter, and associated switching.

5.1.3 Analog-to-Digital Converter Section: The Analog-to-Digital (A/D) Converter section changes the DC output voltage from the Signal Conditioning section to digital information. Using a Large-Scale Integration (LSI) circuit, the unique A/D Converter automatically eliminates zero error. The Continuity Detector determines whether or not the conditioned input DC voltage level or pulse exceeds a predetermined reference level and appropriately activates the audible tone on 2 kΩ range.

5.1.4 Display Section: The Analog-to-Digital (A/D) Converter decodes the BCD into 7-segment information by the onboard decoder-driver. It also includes a backplane drive. The LCD display is driven directly by the Analog-to-Digital converter chip.

5.2 INPUT CIRCUITS

5.2.1 DC Voltage Measurements: The basic DC Voltage circuit is shown in Figure 5-2(A). The DC voltage being measured is connected to the "V-Ω" and "COM" jacks, attenuated according to the range selected and converted into digital information by the A/D Converter.

5.2.2 The A/D Converter provides a basic 200 mV sensitivity range. The input voltage being measured is attenuated to provide 200 mV range by the input divider network. The divider network is used on the 2 V, 20 V, 200 V and 1000 volt ranges.

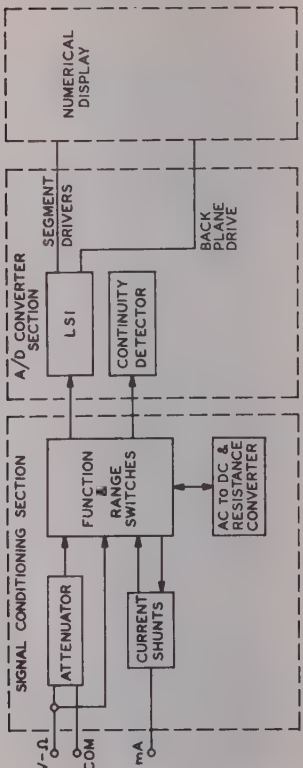


Figure 5-1. Basic System Diagram

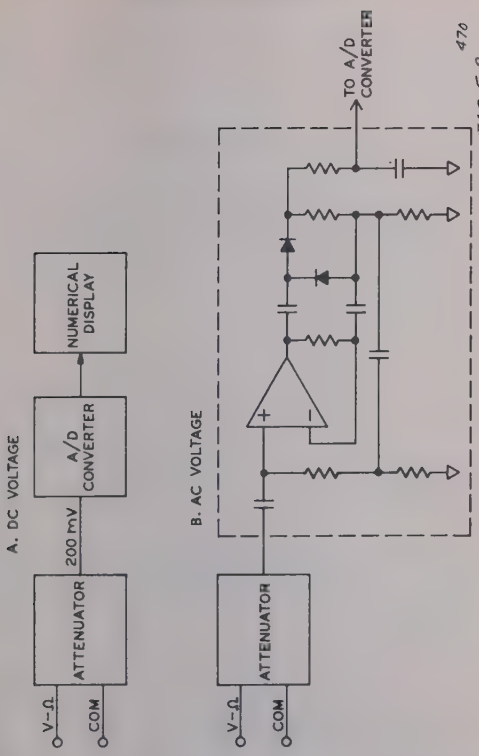


Figure 5-2. Basic Voltage Measurement Circuits.

5.2.3 AC Voltage Measurement:

5.2.4 The basic AC Voltage measurement circuit is shown in Figure 5-2(B).

5.2.5 The AC voltage being measured is connected to the "V-Ω" and "COM" jacks, attenuated according to the range selected by the range switch.

5.2.6 The attenuator attenuates the input signal to provide a 200 mV full scale signal for A/D converter.

5.2.7 The AC to DC Converter uses an effective half wave operational amplifier/rectifier circuit which provides a basic 200 mV full range sensitivity. The converter is average responding but its calibration is based on the rms value of a sine wave.

5.2.8 DC Current Measurements:

5.2.9 The basic DC current measurement circuit is shown in Figure 5-3(A). The current being measured is connected in series with the "mA" or "10 A" and "COM" jacks across the internal precision shunt resistance. The value of the shunt resistance depends on the current range selected. The DC voltage developed across the shunt resistor is measured by the A/D Converter.

5.2.10 The full range sensitivity of the A/D Converter is set for 200 mV. The internal shunt resistance for each current equals 200 mV divided by the full range current. For example, if the full range current is 2 mA, the shunt resistance is 100 ohms.

5.2.11 AC Current Measurements: The basic AC current measurement circuit is essentially the same as the DC current measurement circuit (paragraph 5.2.8), except that the voltage developed across the internal shunt resistance is measured by the AC voltage measurement circuit.

5.2.12 Resistance Measurements:

5.2.13 The basic resistance circuit is shown in Figure 5-3(B).

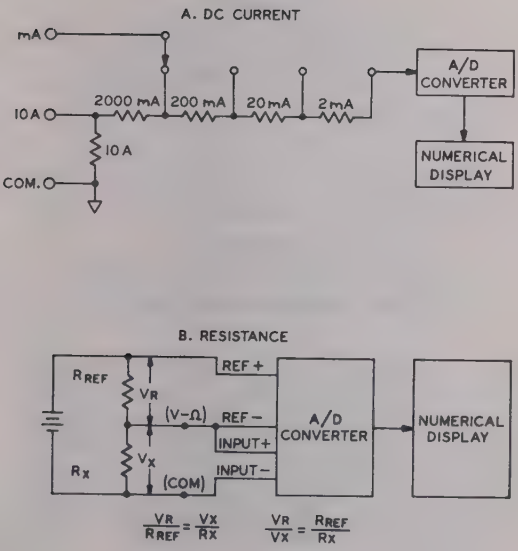


Figure 5-3. Basic DC Current and Resistance Measurements Circuits.

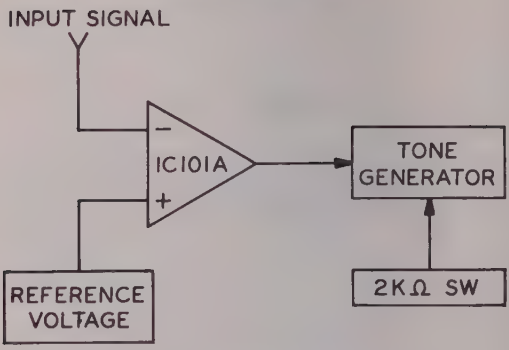


Figure 5-4. Basic Continuity Detector

5.2.14 The resistance being measured, Rx, is connected to the "V-Ω" and "COM" jacks. A voltage ratio is made by comparing the unknown resistance (Rx) with an internal standard resistance R ref. The voltage ratio is applied to the A/D converter to yield a numerical value which is proportional to the unknown resistance as shown in Figure 5-3(B). The ranges of the resistance measurement circuit are determined by the range switch setting.

5.2.15 For semiconductor junction test, refer to paragraph 4.6.2 diode test.

5.2.16 Continuity Detector: The basic circuit is shown in Figure 5-4. The comparator IC 101A compares the input signal, which is the voltage drop across the Rx and the protection resistor, with a Reference Voltage. The high level output of the comparator in conjunction with 2 kΩ range enables the audible tone if a "below reference" signal level is detected.

SECTION VI
OPERATOR MAINTENANCE

6.1 GENERAL

6.1.1 This section will describe the necessary procedures needed to effectively service the 470.

6.2 BATTERY DOOR REMOVAL

6.2.1 The battery door can be removed for servicing by using the following procedure.:

WARNING

Remove all power and connections to the Instrument before removing the battery door. Do not operate the Instrument with the battery door removed.

a. Set the POWER switch to the OFF position.

b. Disconnect the test leads from the Instrument.

c. Unscrew the battery door's captive screw until it stops; with a thumb placed over each one of the "engraved" arrows on the door, depress slightly; then push door up (in the direction of the arrows) to remove it.

d. Reverse this procedure when replacing the door.

6.3 BATTERY INSTALLATION/REPLACEMENT PROCEDURES

6.3.1 Use the following procedure to install or replace the battery:

a. Set the POWER switch to the OFF position.

b. Remove both test leads from external circuit connections and from the 470 input terminals.

c. Remove the battery door.

WARNING

Remove both test leads from input terminals before removing the door. Do not operate the Instrument with the battery door removed.

d. Lift the battery from the compartment and remove the battery connector.

e. Press the battery connector on the new battery and return the battery to the compartment.

f. Replace the battery door.

NOTE: When the battery reaches the end of its useful life, replace it promptly. Failure to do so may result in corrosion at the battery contacts.

6.4 FUSE REPLACEMENT

6.4.1 Both AC and DC current functions are protected up to 2 amps with two fuses, F1 and F2. The fuses are connected in series and are accessible with the removal of the battery door (Figure 6-1).

6.4.2 Fuse types:

F1: 3AG, 2A, 250 V, Normal blow.
F2: BBS, 3A, 600 V

6.4.3 Fuse Replacement Procedure:

a. Set the POWER switch to the OFF position.

b. Remove both test leads from external circuit connections and from the 470 input terminals.

c. Remove the battery door.

d. Carefully remove and replace the defective fuse(s).

WARNING

The combination of fuses provided in this Instrument will perform properly only when the specified types and values of fuses are used. Using incorrect fuses will reduce the protection afforded to the Instrument and can endanger the operator if he's working in high voltage, high power circuits.

e. Replace the battery door.

6.5 CARE:

WARNING

Do not attempt to clean this Instrument with the test leads connected to a power source.

a. Immediately clean all spilled materials from the Instrument and wipe dry. If necessary, moisten a cloth with soap and water to clean plastic surfaces.

b. Do not allow the battery to fully discharge.

c. Whenever possible, avoid exposure to or usage in areas which are subject to temperature and humidity extremes, vibration or mechanical shock, dust or corrosive fumes, or strong electrical electromagnetic interferences.

6.5.1 Monthly Care: Verify Instrument calibration by performing operational checks using known value sources. If a need for calibration is indicated, contact the nearest Authorized Service Center.

6.5.2 Annual Care: It is recommended that the Instrument be returned annually to an Authorized Service Center or to the factory for a complete overall check and calibration.

6.5.3 Storage: When the Instrument is not in use, store it in a location free from temperature extremes, dust, corrosive fumes, and mechanical vibration or shock.

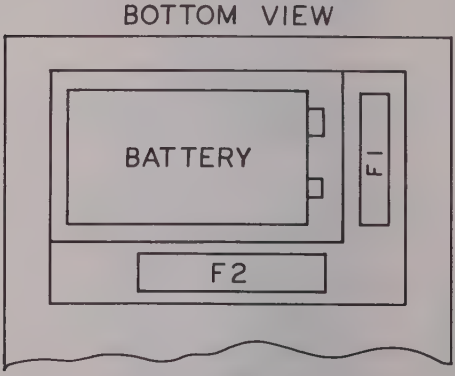


Figure 6-1. Fuse Location, 470.

WARNING

The following servicing instructions are for use by qualified personnel only. To avoid electrical shock, do not perform any servicing other than that contained in the operating instructions unless you are qualified to do so.

SECTION VII
SERVICING INSTRUCTIONS

7.1 GENERAL

7.1.1 The following paragraphs discuss troubleshooting procedures and replacement parts for the 470. Read and heed these instructions carefully.

7.2 TROUBLESHOOTING

7.2.1 If the Instrument does not yield satisfactory results, follow these procedures before attempting maintenance on the Instrument.

a. Review and comply with paragraph 4.3, General Functional check.

b. Check that all switches are positioned correctly for the parameter and range of the value being measured and that the measurement situation is within the rating of the Instrument.

c. Be sure that the battery is properly installed (paragraph 6.3).

d. Ensure that the environment in which the Instrument is being used is within the Instrument specifications.

e. Inspect the device being measured and the measurement test set-up to ensure that proper shielding and grounding techniques have been used. Also, consider whether the Instrument is significantly affecting the circuit being measured.

7.2.2 If the steps taken in paragraph 7.2.1 do not yield satisfactory results, refer to the troubleshooting chart (Table 7-1). If further assistance is needed, contact an Authorized Service Center.

Table 7-1. Troubleshooting Chart.

SYMPTOM:

"Lo Bat" appears on display.

PROBABLE CAUSE:

Battery reached the end of its useful life.

CURE:

Replace the battery as noted in paragraph 6.3.

SYMPTOM:

No display or faded display when the Instrument is turned "ON."

PROBABLE CAUSES:

Battery defective, not installed properly, making poor contact, or missing.

CURE:

Remove battery door and check that the battery is installed correctly and making good contact. (Refer to paragraph 6.3.)

SYMPTOM:

Indications fluctuate and/or drift, even though indication is satisfactory at 000 with the input terminals shorted, and at 1000 counts when using a stable and low impedance source.

PROBABLE CAUSES:

Fluctuations, and/or drift are being generated by the circuit being measured or the measurement test set up.

CURE:

Use proper shielding gounding techniques and connections to minimize "pick-up" of unwanted signals due to ground loops, poor connections, and capacitive and/or inductive coupling.

SYMPTOM:

Slow response. Operation OK when using a low impedance input.

PROBABLE CAUSE:

Parameter being measured has a high source impedance.

CURE:

None required.

SYMPTOM:

Accuracy not within specifications when checked with a stable higher accuracy (at least 5 times better) low impedance (voltage measurements) source.

PROBABLE CAUSE:

Instrument is out of calibration.

CURE:

Contact the nearest Authorized Service Center.

SYMPTOM:

Operation normal on all functions and ranges except AC and DC Current.

PROBABLE CAUSE:

Current fuse F1 open.

CURE:

Replace fuse F1 (Refer to paragraph 6.4).

SYMPTOM:

Operation normal on all functions and ranges except AC and DC Current (F1 checks OK).

PROBABLE CAUSE:

Current fuse F2 open.

CURE:

If F2 has been blown, a large amount of energy has been applied to the current ranges. Circuit conditions must be corrected before replacing F2. (Refer to paragraph 6.4.)

7.3 REPLACEMENT PARTS AND SCHEMATIC DIAGRAM

7.3.1 This section contains information for ordering replacement parts and shows the Schematic Diagram (Figure 7-1). Table 7-2 lists parts in alpha-numeric order of their reference designators and indicates the description (Refer to Table 1-1 for Items and Accessories Furnished With This Instrument.)

7.3.2 To obtain replacement parts, address order to the nearest Authorized Service Center (listed on the last pages of this manual). Refer to paragraph 2.3.1 for ordering instructions.

Table 7-2. Replacement Parts

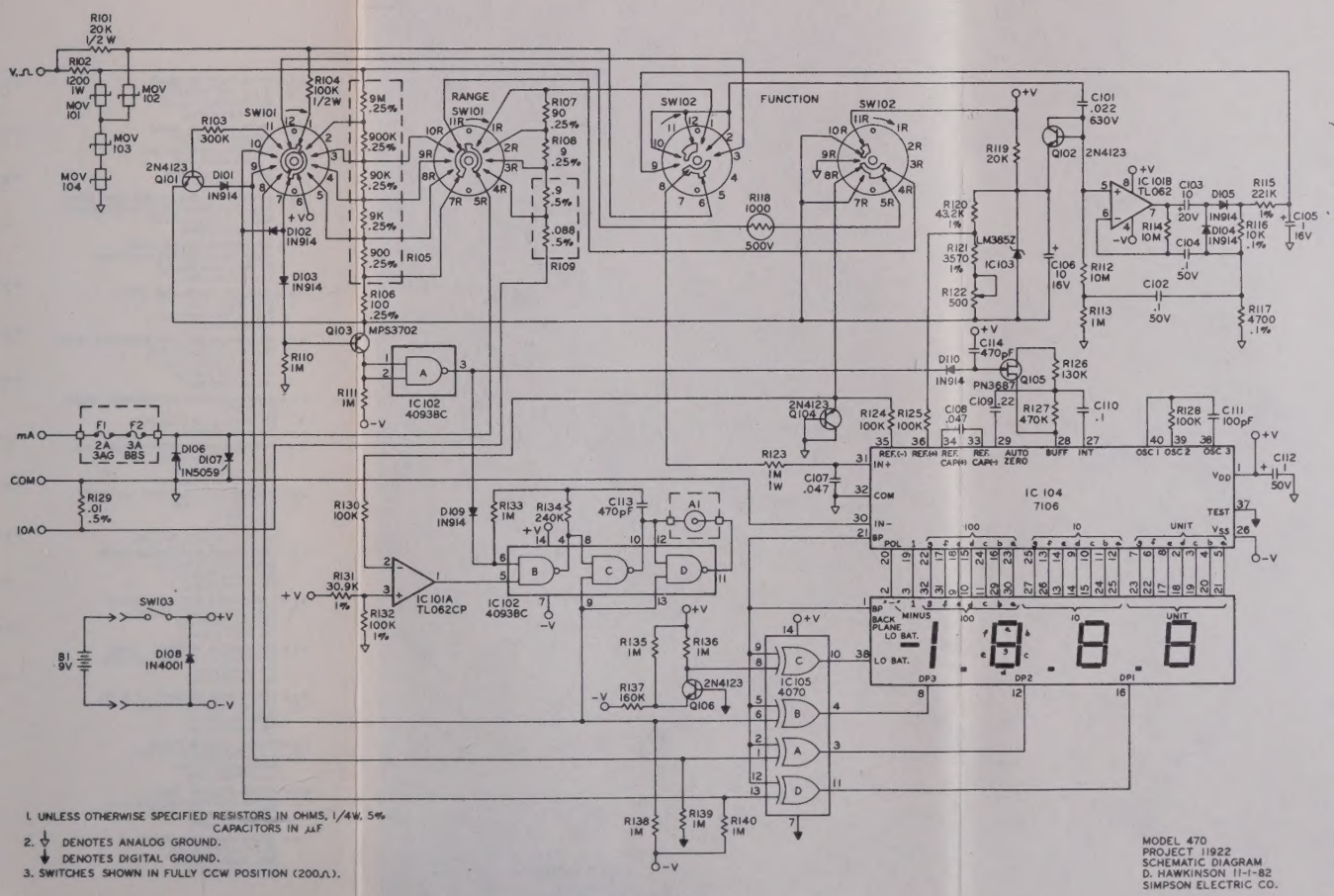
Symbol	Description	Part No.
B1	Battery, 9 V	5-114907*
	Test Lead Set, Red and Black w/o Alligator Clips	00043
	Alligator Clip Accessory Kit	10-864240
F1	Fuse, 2 A, 250 V, 3AG	1-112911
F2	Fuse, 3 A, 600 V, BBS	6-110906

*Batteries are standard items replaceable through local retail stores.

C101	Capacitor, 0.022 μF, 630 V, Polyester	6-112832
C102, 104	Capacitor, 0.1 μF, 50 V, Ceramic	5-119660
C103	Capacitor, 10 μF, 20 V, Tantalum	6-110306
C105	Capacitor, 1 μF, 16 V, Tantalum	5-115531
C106	Capacitor, 10 μF, 16 V, Electrolytic	5-117205
C107, 108	Capacitor, 0.047 μF, 100 V, Polyester	6-112830
C109	Capacitor, 0.22 μF, 100 V, Polyester	6-111252
C110	Capacitor, 0.1 μF, 160 V, Polypropylene	6-112831
C111	Capacitor, 100 pF, 1 kV, Ceramic	5-113217
C112	Capacitor, 1 μF, 50 V, Electrolytic	6-112908
C113, 114	Capacitor, 470 pF, 500 V, Ceramic	1-115832
D101, 102, 103, D104, 105, 109, D110	Diode, IN 914	5-112004
D106, 107	Diode, IN 5059	5-113826
D108	Diode, IN 4001	5-113200
IC101	IC, TL062	6-110905
IC102	IC, CD4093B	6-112216
IC103	Diode, Reference, 1.2 V LM 385Z	6-112221
IC104	IC, 7106	6-110920
IC105	IC, CD4070B	6-111150
MOV 101, 102, MOV 103, 104	MOV	6-110694
Q101, 102, Q104, 106	Transistor, 2N4123	5-115931
Q103	Transistor, MPS 3702	5-113864
Q105	Transistor, PN 3687	6-112894

R10'	Resistor, 20 k, 5%, ½ W	5-119354
R102	Resistor, 1.2 k, 10%, 1 W	5-116891
R103	Resistor, 300 k, 5%, ¼ W	5-119418
R104	Resistor, 100 k, 5%, ½ W	5-118625
R105	Resistor, Special Attenuator	6-112780
R106	Resistor, 100 Ω, 0.25%, ¼ W	6-112819
R107	Resistor, 90 Ω, 0.25%, ¼ W	5-116272
R108	Resistor, 9 Ω, 0.25%, ¾ W	5-118410
R109	Resistor, .9 Ω and .088 Ω, 0.5%	6-112823
R110, 111, 113, R133, 135, 136		
R138, 139, 140	Resistor, 1 M, 5%, ¼ W	5-118305
R112, 114	Resistor, 10 M, 5%, ¼ W	5-116632
R115	Resistor, 221 k, 1%, ¼ W	5-117526
R116	Resistor, 10 k, 0.1%, ¼ W	6-112821
R117	Resistor, 4.7 k, 0.1%, ¼ W	6-112820
R118	Thermistor, 1 k	6-112329
R119	Resistor, 20 k, 5%, ¼ W	5-119645
R120	Resistor, 43.2 k, 1%, ¼ W	6-111254
R121	Resistor, 3.57 k, 1%, ¼ W	5-113286
R122	Potentiometer, 500 Ω, 10%, ½ W	6-111611
R123	Resistor, 1 M, 5%, 1 W	6-111248
R124, 125, R128, 130	Resistor, 100 k, 5%, ¼ W	5-118168
R126	Resistor, 130 k, 5%, ¼ W	5-117709
R127	Resistor, 470 k, 5%, ¼ W	5-118169
R129	Resistor, 0.01 Ω, 0.5%	6-112829
R131	Resistor, 30.9 k, 1%, ¼ W	6-112822
R132	Resistor, 100 k, 1%, ¼ W	5-117711
R134	Resistor, 240 k, 5%, ¼ W	6-111124
R137	Resistor, 160 k, 5%, ¼ W	6-112360
SW101	Range Switch	6-112825
SW102	Function Switch	6-112824

Liquid Crystal Display	6-112817
Connector, Zebra Strip	6-112211
Bezel	3-261083
Cable, Flat, 13 Conductors	6-112826
Connector, Battery	6-111244
Slide Switch	6-112827
Housing Transducer	3-261130
Transducer Assembly	10-864958
Cover, Knob	6-112877
Knob	6-112883
Case Assembly, Top, Brown	10-865028
Case Assembly, Bottom, Brown	10-865024
Cover Assembly, Battery, Brown	10-560327
Bail Assembly, Brown	10-865019
Shield	6-112931
Panel Overlay, Upper, Brown	6-112987
Panel Overlay, Lower, Brown	6-112988
Screw, #4-40X .234″ lg., Fillister Head	6-132902
Screw, #4-40X .475″ lg., Fillister Head	6-132903
Screw, #2-56X .165″ lg., Pan Head	6-132901
Connector, 2 Circuit, Male	6-112816
Screw, #2-56X 3/16″ lg., Flat Head	6-132900
Switch Shaft & Index Assembly	6-112833
Screw, #2-56X 3/16″ lg., Binder Head	1-189521
Case Assembly, Top, Gray	10-865027
Case Assembly, Bottom, Gray	10-865023
Cover Assembly, Battery, Gray	10-560326
Bail Assembly, Gray	10-865018
Panel Overlay, Upper, Gray	6-112836
Panel Overlay, Lower, Gray	6-112835



1. UNLESS OTHERWISE SPECIFIED RESISTORS IN OHMS, 1/4W, 5%
   CAPACITORS IN µF
2. ⏚ DENOTES ANALOG GROUND.
   ▼ DENOTES DIGITAL GROUND.
3. SWITCHES SHOWN IN FULLY CCW POSITION (200Ω).

MODEL 470
PROJECT 11922
SCHEMATIC DIAGRAM
D. HAWKINSON 11-1-82
SIMPSON ELECTRIC CO.

Figure 7-1. Schematic Diagram.

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☐ BROWNELL-ELECTRO INC.
3201 Woodpark Blvd.
Tel. 704/597-1270

★★★ **NORTH CAROLINA, RALEIGH 27604**
☐ METER METRICS
5821 North Boulevard
Tel. 919/872-5466

★★★ **OHIO, CLEVELAND 44105**
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INSTRUMENT LABORATORY
Div. of Pioneer-Standard Electronics, Inc.
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★★★ **OHIO, CLEVELAND 44136**
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Granville Road., Suite 192
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☐ E. I. L. INSTRUMENTS INC.
96A Westpark Road
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★★★ **OHIO, DAYTON 45424**
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Tel. 503/283-0132

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INSTRUMENTS INC.
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★★★ **PENNSYLVANIA, PITTSBURGH 15238**
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620 Alpha Drive RIDC Pk.
Tel. 412/782-3770

★★★ **PENNSYLVANIA, PITTSBURGH 15221**
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Tel. 412/731-5230

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Villa Nevarez
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★★★ **TENNESSEE, KNOXVILLE 37922**
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Tel. 615/966-3441

★★★ **TENNESSEE, MEMPHIS 38118**
☐ BROWNELL-ELECTRO INC.
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Tel. 901/795-8487

★★★ **TENNESSEE, MEMPHIS 38104**
INSTRUMENT REPAIR SERVICE
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Tel. 901/278-0762

★★★ **TENNESSEE, NASHVILLE 37210**
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☐ METERS & INSTRUMENTS CORP.
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Tel. 713/644-1631

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4832 Caroline
Tel. 713/524-0528

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P. O. Box 2373
Tel. 915/332-0565

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1306 North Texas
Tel. 915/337-3412

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Tel. 703/354-4330

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REPRESENTATIVES
7400 White Pine Road
Tel. 804/275-1431

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1312 S. 96th Street
Tel. 206/762-0850

★★★ **WASHINGTON, SEATTLE 98105**
☐ EICHER-RICHARDS COMPANY
2727 N. E. Blakeley Street
Tel. 206/523-7888

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BLACKS-INDUSTRIAL INC.
N. 401 Helena - Box 3286
Tel. 509/534-9353

★★★ **WISCONSIN, MILWAUKEE 53202**
E-M INSTRUMENTS INC.
153 No. Milwaukee Street
Tel. 414/272-7799

★★ **WYOMING, LANDER 82520**
METER SPECIALISTS, INC.
P. O. Box 595 (Mail)
Hiway 287 West (UPS)
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